PATENT APPLICATION
Navy Case No. **84,339**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION FOR LETTERS PATENT

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT **Chris Herndon and Mike Rupar** who are citizens of the United States of America, and are residents of, **Alexandria, VA, and Fairfax, VA`** invented certain new and useful improvements in **"TELECOMMUNICATIONS INFRASTRUCTURE LINKAGE METHOD AND SYSTEM"** of which the following is a specification:

Please Contact Preparer:
Lawrence G. Legg
Reg. No. 34,208
Tel: 202-404-1559
Date: October 24, 2003

TELECOMMUNICATIONS INFRASTRUCTURE LINKAGE METHOD AND SYSTEM

The present application claims the benefit of the priority filing date of provisional patent application no. 60/420,680, filed October 24, 2002, and incorporated herein by reference.

Field of the Invention

This invention relates to a method and system device for providing mobile emergency telecommunications and video-streaming. More particularly, the invention relates to a method and system for linking incompatible or disparate communications protocols and service providers and for providing video-streaming from a site, during an emergency or in other situations requiring the rapid establishment of a tele- and video-communications infrastructure.

Background Art

There are many systems directed to infrastructure deployment via satellite communications. From the first use of communications satellites in the early 1960's it was evident that these systems would provide a mechanism to provide communication assets where there were no terrestrial links. It wasn't until the graphic display of damage to our terrestrial networks on Sept 11th 2001, that satellite communications could provide a critically needed backup for our first responders. What had only been deployed by the Military, prior to Sept 11th, could now be used to solve many of the deficiencies that have repeatedly surfaced from agencies all across the United States.

One such system, as disclosed in U.S. Patent Application No. 09/774,207 filed January 30, 2001 and published Aug. 1, 2002 as US 2002/0101831A1, and incorporated herein by reference, describes a system that includes a mobile auxiliary communications facility equipped with mechanisms allowing the system to link to a satellite from a desired site. A disadvantage of this system is that it continues to rely on a commercial infrastructure in order to provide communications capabilities at the deployed site. Reliance on a commercial infrastructure is disadvantageous because during emergency conditions, such as at the WTC or Pentagon on September 11, 2001, the commercial

infrastructure may be overloaded with users and rendered essentially useless. Another disadvantage of these systems is that emergency communications between disparate emergency service providers are not feasible or enabled, such as between fire department personnel and police personnel, who may be using incompatible wireless radio equipment operating on different frequencies. This can occur both when the emergency personnel from different municipalities respond to one or more sites involved in an emergency situation and also when those from the same municipality for whatever reason employ incompatible equipment. It may also be impractical, as at the World Trade Center on 9/11/2001, to distribute on-scene compatible emergency equipment to all responders, due to the infeasibility of inventorying and supplying large quantities of radios or other wireless telecom gear and also due to the fact that many responders have already been deployed around the site.

Yet another disadvantage is that these systems provide for just telecommunications operations but do not include high quality on-scene video capabilities or a video-streaming capability from an emergency site to a command center or other locations. It can prove essential to emergency control and decision-making to provide live video-streaming from the site to remote users.

There is, therefore, a need for a mobile communications system that retains full capabilities under emergency conditions and includes the additional capabilities of enabling communications between all emergency responders and all desired sites.

Summary of the Invention

According to the invention, a mobile communications infrastructure platform includes a networking module that includes a plurality of inputs and outputs and a POTS line connection; a satellite module coupled to the networking module for uplinking and downlinking a satellite datastream with a communications satellite; a video module for providing a video datastream to the networking module; and a wireless telecommunications module bidirectionally coupled to the networking module for receiving telecom data from and transmitting telecom data to the networking module. The wireless telecommunications module includes a VOIP interface coupled to the networking module, a land mobile radio coupled to the VOIP interface, and a private cellular network.

Also according to the invention, a method of establishing the mobile infrastructure linkage system at a desired location includes transporting the platform to the location; eestablishing a satellite signal link to the platform; booting platform computers, networking modules, video modules, and wireless modules; programming the land mobile radio to a specific region or agency; commencing satellite signal acquisition; and establishing a satellite communications link between the platform and a second system node. The second system node may, for example, be another such platform or platforms, or an earth station.

The invention provides a bi-directional patch or link between disparate communications equipment and protocols at a site and to off-site wireless radio equipment.

The invention also provides on-site high quality video capabilities and video streaming to off-site locations, including from an emergency site to a command center.

The military, when deployed in other nations or theaters of operations, will use host nations infrastructure, and in many cases is critically dependant on it. The InfraLynx™ platform according to the invention provides high assurance telephony, network, and radio connectivity to remote locations, such as disaster sites and theater command posts from other remote or CONUS locations. The backbone communications path can be any combination of terrestrial wired/fiber infrastructure, military satellite, or commercial satellite assets. Telephony connectivity provides access to the PSTN (Public Switched Telephone Network), DSN (Defense Switching Network), and commercial or STU/STE phones world-wide. Network connectivity is provided allowing multiple simultaneous high assurance VPN (Virtual Private Network) connections to the Internet, NIPRNET, SIPRNET, coalition, and allied networks. The system provides local radio and cellular connections. Cellular connections are private and independent from local services but also can be automatically patched to the phone services or local radios. Local radios can be patched to other similar/dissimilar radios and phone services. Local data radio services can also be patched to each other and to the remote networks. Radio assets are dynamically tailorable to each employment, allowing interoperability with fielded systems. Radio, telephony, and network connections to the global grid and infrastructure are made using widely accepted industry standard interfaces. NSA Type I strong encryption will be employed for protection of data at rest and data in transit.

Additional features and advantages of the present invention will be set forth in, or

be apparent from, the detailed description of preferred embodiments which follows.

Brief Description of the Drawings

FIG. 1 is a schematic diagram of a mobile infrastructure linkage system according to the invention.

FIG. 2 is a schematic diagram of a a sample network configuration with two programmable interfaces interconnecting two ATM switches according to the invention.

FIG. 3 is a schematic diagram of a wireless module with interfaces for land mobile radios and an audio distribution system according to the invention.

FIG. 4 is a schematic diagram of a VOIP interface connected to a micromatrix processor according to the invention.

FIG. 5 is a schematic diagram of a video module according to the invention.

FIG. 6 is a schematic diagram of a hub system configuration according to the invention.

FIG. 7 is a schematic diagram of a mesh system configuration according to the invention.

FIG. 8 is a block diagram of a satellite communications flow path according to the invention.

FIG. 9 is a graph showing satellite spectral usage according to the invention.

FIG. 10 is a graph showing an optimized spectrum utilization of a modified mesh system configuration according to the invention.

FIG. 11 is a graph showing an optimized spectrum utilization of a hub system configuration according to the invention.

Detailed Description of the Preferred Embodiments

Notation Used Throughout

The following notation is used throughout this document.

Term	Definition
ATM	Asynchronous Transfer Mode
IP	Internet Protocol
LAN	Local Area Network
VOIP	Voice Over Internet Protocol

Referring now to **Figure 1**, a mobile infrastructure linkage system **10**, that is designed as a modular platform for installation in and/or transport on a communications van, vehicle, or trailer or the like, includes a networking module **12** for receiving and transmitting a plurality of telecommunications and other datastreams. Module **12** includes a LAN 13 and an ATM switch **14**, such as the PacketStar PSAX-1250 manufactured by Lucent Technologies. Switch **14** includes both routing and multiplexing/demultiplexing capabilities, and it includes a DS3-to-internet interface **16** and Ethernet interfaces **18**, each of which have bi-directional connections to the LAN **13**, and a DSO interface **20**. The ATM Switch **14** is also required when bulk or network encryption devices are injected into the network architecture. System **10** further includes a satellite module **22** that includes a transceiver **24**, an antenna **26** with antenna/antenna controller **28**, a 70 MHz summer/splitter **30** for receiving and monitoring an output signal **31** of transceiver **24**, a programmable bi-directional satellite-network interface **32** coupling interface **16** with satellite module **22**, and a modem **34** coupling programmable interface **32** with transceiver **24**. Modem **34** has an input **36** for receiving a satellite downlink output of summer/splitter **30** and an output **40** for providing a framed RS449 serial output signal to a DS-3 input channel of programmable interface **32**. Programmable interface **32**, which in a preferred embodiment is an ATM link adaptation, such as the CLA-2000/ATM™ (the COMSAT

link accelerator, or "CLA"), manufactured by Comsat Corp, enables inter-connection of standard ATM equipment over non-standard rate WAN links. The CLA is a networking device that enables the interconnection of Asynchronous Transfer Mode (ATM) networks over Wide Area Network (WAN) links, especially satellite and wireless links. The CLA provides efficient bandwidth utilization, improves link quality, and significantly improves the performance of applications operating over satellite and wireless ATM networks. The CLA has utility in fixed or mobile, satellite or terrestrial wireless links, and operates in a range from fractional T1 to 8.448 Mbps data rates. The CLA connects ATM switch **14** with DS3 interface **16** over a 8.448 Mbps satellite link, although the sustained rate for sending ATM cells is typically no higher than 93% of 8.448 Mbps. The CLA converts the RS449 serial output of modem **34** to be converted to DS3. This is not only a physical conversion, but also a rate conversion/buffering. The serial RS449 data to and from the modem runs at a maximum rate of 9.3Mbps while the DS3 interface of the ATM switches run at a constant rate of 44.736Mbps. Once converted to DS3, the signal is interfaced to networking module **12**.

Referring also now to **Figure 2**, shown is a sample network configuration with two such interfaces **32** interconnecting two ATM switches **14** over a WAN link.

As noted above, transceiver **24** includes a satellite antenna/antenna controller **28** that in a preferred embodiment is a boom-mounted antenna such as the Vertex/RSI satellite antenna system manufactured by Vertex Corp. In a preferred embodiment using this system, the up-converter is mounted on the boom of the satellite dish as opposed to the fixed side of the satellite dish. This removes the requirement of a flexible waveguide assembly for the commercial antenna, allowing a replacement with standard coaxial cable, thereby removing an expensive and high maintenance item from the configuration.

Networking module **12** is further connected to a wireless module **44** via the Local Area Network (LAN). Wireless module **44** includes a mobile internet and cellular telephone backup module **46**, an 802.11 wireless access point **48**, and a VoIP interface **50** each of which is bi-directionally connected to the Networking module. Internet/cell telephone module **46** integrates and includes a complete wireless cellular base station. Furthermore, whereas cellular base stations typically draw dial tone from physical connections from the public switched telephone network (PSTN), the invention also includes the creation of dial tone remotely to allow the cellular base station to function seamlessly as a "private" cellular provider exclusively for users of system **10**. Many

systems employ cell phones to create usable dial tone on the remote end. The integration of a complete cellular base station allows system **10** to act as the cellular service provider at an incident site, which is a commercial system manufactured by Wheat Wireless, Inc. System **10** employs the cellular base stations as AMPS, CDMA or GSM, depending on user requirements. The modular architecture allows for the quick reconfiguration from each of these types of cellular base stations. Although this is a capability that many cellular service providers employ during surge events with portable Cell-on-Wheels (COWs), wireless module **44** includes an interface that allows the cell site to act as a "private node". This private node allows the Infralynx to provide service to only authorized individuals at an incident site. These "authorized individuals" can be programmed on the fly using their existing cell equipment or be provided a secure handset from the Infralynx equipment. Once the cellular capability has been established, the user can place calls to other users on the private cellular system. The system automatically detects the number that has been dialed and directs it to the appropriate handset. The baseline system supports 64 handsets but can easily be expanded to support additional users. The utility of this cell system is greatly expanded by terminating the cellular switch into the dial tone that is created by system **10**. With eight or more POTS lines terminated into the cell switch, users then have the ability to dial out from the cell system into the Public Switched Telephone Network (PSTN). System **10** includes a dial plan that allows a cellular user on the system to direct dial other cell users, dial 3 digit extension to get any other wired user of system **10** or dial "9" to get an outside connection. An outside connection is defined as a user outside the service area of system **10**. This serves as an alternative implementation to the Wireless Government Emergency Telecommunications Service (GETS).

Module **46** also includes TCP/IP connection capability while a vehicle carrying system **10** is in motion. A commercial mobile internet terminal, manufactured by KVH Corp., is integrated into system **10** to provide an operator with internet/email while in transit to an incident site. Also included is a novel backup mobile internet connection in the event that a clear view to the southern sky does not exist (urban environments). This uses one to three commercial wireless cards configured and bonded together to form a high speed connection for the users.

Referring also now to **Figure 3**, wireless module **44** further includes land mobile radios ("LMRs") **52** preferably covering frequencies in the range of HF (2MHz-30MHz),

Low Band (39MHz-54MHz) VHF (146-174MHz), UHF (406-450, 450-470MHz), Public Safety (800MHz). LMRs **52** as shown include nine off-the-shelf radios as the baseline configuration. These LMRs are discrete, single function radios that operate in the stated specific frequency bands. Each LMR **52** is equipped, from the factory, with an audio/PTT interface **54** as shown, allowing simultaneous connection to a processor **56**, radio programming ports **57**, and a Clear Com audio distribution system **58**. This is accomplished by modifying the manufacturers interface on the radio. The external interface must be impedance matched to maintain voice quality. Also it requires that the push-to-talk (PTT) signal is available on the rear interface. Depending on radio type, modifications are made on the internal circuit boards of the radios to change resister values to change the transmit audio impedance to allow multiple devices to be connected simultaneously and enable external PTT. This modification is available as a factory option when the radio is ordered. Processor **56** is preferably an ACU-1000, manufactured by JPS Communications, and is a key piece of the radio interoperability. The ACU-1000 allows the signal that is being received by one radio to be "translated" to other frequencies. This allows agencies with dissimilar and incompatible equipment to communicate with one another. Referring also now to **Figure 4**, VoIP interface **50** connects multiple facilities together through a micromatrix processor **62** for improved dispatching ability. VOIP interface **50** in a preferred embodiment is the Network Extension Unit NXU-2 model, manufactured by JPS and designed for use with the ACU-1000. The NXU-2 converts local radio traffic to VOIP. Once in VOIP, the radio traffic is easily transported over network connections. The NXU-2 converts the analog audio to VOIP for transport. The NXU-2 consists of two main assemblies – a network processor and a digital signal processor (DSP). The network processor, a Motorola Coldfire MCF5206e, handles all the Internet Protocol (IP) related tasks, and provides an Ethernet interface to the network. The DSP, a Texas Instruments TMS320VC5409, handles all the audio-related tasks, including the voice compression and decompression. The NXU-2 can be configured as a client or a server. Servers can only accept IP connections from clients, and clients can only make and break connections from servers. Once a connection is established, however, the operation of an NXU-2 is the same regardless of whether it's a client or a server. When power is applied to an NXU-2, it either waits for a connection (if it's a server) or it attempts a connection to a server (if it's a client). The server it attempts to connect to is the one that has an IP address identical to the SRVRIP address

programmed in the client. This connection is a standard TCP/IP connection on port 1221. Once a connection is established, each NXU-2 DSP begins converting analog data into digital data and compressing it to reduce the amount of bandwidth it will take to send it across the network to the associated unit. This conversion/compression process runs continuously, even if data is not currently being sent across the network. The network processor on each NXU-2 shares a common area of memory with the unit's DSP processor, allowing data to be exchanged between the two processors quickly and easily. When the network processor sees the unit's COR input line go active, it collects the frames of compressed digital audio from the DSP and packages them into packets for transmission across the network. These audio packets are sent to the NXU 2 at the other end of the link using UDP on port 1221. In addition to the audio information the packets also contain information about the status of the COR and AUX IN lines. When these packets are received at the other end of the link, the receiving network processor separates the audio from the status information and updates the unit's PTT output and AUX OUT lines based on this status information. The audio frames are then sent to the DSP for decompression. When the DSP has completed the decompression of a frame, it sends the resulting samples to the digital-to-analog (D/A) converter; the resulting analog audio signal is available at the units audio output port. This process can run in both directions simultaneously since the NXU-2 is capable of full duplex operation. Transmission of RS-232 data is handled solely by the NXU-2 network processor, and is sent using TCP on port 1221. If COR is not active the NXU-2 will send an empty packet every four seconds in order to keep the connection from timing out. The DSP master clock is the source of timing for A/D and D/A conversions as well as for transmission of packets across the network. The buffer management software in the NXU-2 can account for slight differences in master clock frequencies on each end, and can account for network jitter or packets, which arrive late.

Wireless access point **48** allows laptops and other wireless devices to connect to the data services provided by system **10**.

System **10** utilizes the Clear Com audio distribution system, for example the MMX24 or the Compact 72 manufactured by Clear Com Corp. and originally developed for the television production market, and adapts it for use with LMR's **52** and other audio sources to provide users with a complete audio distribution that is run over CAT5e cable. This dramatically simplifies the installations in the field by eliminating the individual

console/handset wiring for each LMR **52** and replacing it with a single CAT5e cable. This is a key attribute that allows system **10** to be setup and configured in minutes as opposed to hours using conventional wiring techniques. The radio programming kits that can be purchased with LMRs **10** allow the communication operators to change frequencies and talk groups. This is normally done in the communication facilities, not in the field. This is a contribution factor to the lack of interoperability. Many of the radio systems used today could potentially operate in frequency ranges that lie close to each other. And most of the agency radios operate on different frequencies in these close frequency ranges. If the radios can be re-programmed in the field there is a much better chance that the different agencies could communicate. System **10** integrates the radio programming kits into the configuration, so the radios can be modified on the fly. This allows system **10** to support substantially more users with less radio equipment.

System **10** further includes a video module **64**. Referring also now to **Figure 5**, video module **64** includes a four channel MPEG-2 video server **66**. With three cameras **68** on the perimeter of the vehicle carrying system **10** and a fourth high-powered camera **70** on a pneumatic mast (not illustrated), video server **66** streams all four camera feeds out over the internet. Video server **66** is, for example, a commercially available device such as the Axis 250 Video Server, manufactured by Axis Corp. Video server **66** receives analog video input from an analog camera **68** or **70** first into an image digitizer **72**. Image digitizer **72** converts the analog video to digital format. The digital video is transferred to an encoder and compression chip **74**, where the images from the video are compressed to either JPEG still images or MPEG video. The conversion to digital format and compression to JPEG images are performed by a camera controller and video compression processor **76**. Processor **76**, containing a CPU **78**, an Ethernet connection **80**, serial ports **82**, and an Alarm input and relay output **84**, represents the "brain" or computing functions of video server **66**. It handles the communication with the network. The CPU processes the actions of the Web server and all other software (e.g. drivers for different Pan/Tilt/Zoom cameras). The Ethernet connection enables a direct network connection. The Serial ports (RS-232 and RS-485) enable control of the cameras' Pan/Tilt/Zoom function or surveillance equipment such as time-lapse recorders. A modem can also be connected. Overall, the function of video server **66** is to convert traditional CCTV signals into TCP/IP packets that can be viewed by any browser in the network (including across the satellite link). The video server also compresses the bandwidth required by each video

stream to facilitate simultaneous network usage. Compression is necessary because a fully uncompressed video feed can require as much as 165Mbps (a much larger throughput than the network or the satellite link allows). Encoding and compression is all consistent with the MPEG-2 format.

Video server **66** includes a “patch” designed and applied that allows the encoder to compensate for slow acknowledgement due to the 500ms delay added by extending the TCP connection over satellite. Adapting the Video Server for coherent use over the satellite link requires a PC connection to be established into the server using the Telnet utility. Using scripting protocols provided in wu-ftp, standard operating protocols are modified to reflect the augmented latency. This patch is applied by telneting into the embedded operating system of the video encoder and then modifying the parameters of the commercial wu-ftp program based on the characteristics of the satellite links. Then it is re-flashed to the onboard memory.

Referring now to **Figure 6** , the Infralynx™ system **10** is deployed in a hub configuration **100** for a particular situation or at a desired location. System **10** arrives on scene, for example onboard a custom, integrally mounted, retrofitted vehicle **102**. Vehicle **102** is preferably parked or positioned giving consideration to satellite look angles and the “dead zone” of its antenna pedestal. Stabilization jacks are deployed, and an internal generator or vehicle engine is switched over to provide power to the system. Antenna controller **28** initializes GPS and flux gate compass. The satellite system is entered by the user. Signal acquisition begins. During signal acquisition, computers and networking modules, video modules, and wireless modules are booted. LMR’s **52** are programmed to the specific region or agency. Signal acquisition occurs, and the establishment of a satellite communications link between the deployed system **10** and a satellite teleport facility **104**, such as the Naval Research Laboratory facility in Washington, D.C., another available government facility, or a commercial entity, is made. System **10** is then operational.

Figure 7 illustrates a mesh configuration deployment **200** of system **10**. The distinction between hub configuration **100** and mesh configuration **200** is that in the hub configuration, one node serves as the primary connection to the commercial infrastructure outside the affected area. In the mesh configuration **200**, each node is performing the same function with no mode connected to the commercial infrastructure, i.e. having no dependence on it. Multiple systems **10** are each mounted on a mobile platform such as a vehicle **202**. Deployment in the mesh configuration is identical to that of the hub

configuration. The primary difference is in the connection to the existing infrastructure. In the hub configuration, connections to the PSTN and data networks are through the earth station. In the mesh configuration, private dial tone and data networks are created between the nodes as the signals are acquired at each node. Each node in the mesh configuration acts both as the earth station and the remote node of the hub configuration. This eliminates the dependencies on the commercial service providers but still allows full communications, both data and voice, from the incident site to each of the other nodes in the network. It should be noted that "nodes" as used herein means each particular installation of a system **10** in the deployed configuration.

To accommodate this process, the satellite communications link begins with the purchase and/or use of existing satellite space segment from a satellite vendor. One of the unique aspects of system **10** is the creative use of the space segment. Segment is sold by bandwidth utilization. The way system **10** implements Asynchronous Transfer Mode (ATM) as the protocol over the satellite communication link as discussed above allows for substantially less space segment to be purchased without degradation of the performance of the network. The directional arrows in **FIGS. 6** and **7** are all two-way, except for the video feeds, to indicate in each instance a bi-directional data or communications channel other than for the video feeds.

Referring also now to **Figure 8,** once the satellite link has been established, a received signal is reduced from the Ku-Band spectrum to L-Band and eventually to base band (70 MHz) at the satellite modems. More particularly, the satellite signal is received by the Low Noise Block down-converter (LNC) and stepped down to L-Band (500 MHz – 1500 MHz). The signal then enters the transceiver **24** where it is block down converted again to 70MHz base band. One such appropriate transceiver is made by Anacom, providing programmable adaptation for use throughout the world (where other frequency conventions may apply) with a corresponding LNC, as well as an RS-232 monitor and control port for remote operation. The transceiver allows the signal to be interfaced directly to the commercial satellite modem **34** at the Receive I/F connection of the modem. The transmit path is the reverse. From the Transmit I/F connection of the modem, the signal leaves as 70 MHz, and subsequently out of the up-converter at Ku Band into the High Power Amplifier (HPA) (not illustrated) for transmission. The satellite modems **34** then convert the signal to RS-449 (serial) data to the serial-to-DS-3 converter/accelerator **32** and finally to the DS3 interface of the ATM Switch as discussed above. At this point

the satellite link can effectively be multiplexed/de-multiplexed by the next functional module into native formats of telephone lines (POTS), TCP/IP network traffic and video/audio. Once in the native format, the uses are virtually endless. System **10** becomes a complete, remote extension of the data and network services that can support many different applications.

Figure 9 is a graph comparing the utilization by system **10** ("Infralynx") to traditional equipment. The optimization of the bandwidth allows the same network performance to be achieved using only 10MHz of bandwidth as opposed to the conventional approach which requires 50 MHz of bandwidth. Advanced encoding techniques, forward error correction and compression implemented in the satellite data modem are key to achieving the space segment performance shown therein. **Figure 10** is a graph showing the spectrum utilization of a system **10** in the modified "mesh" configuration of **Figure 6**. This is a point-to-multi-point configuration that allows services to be distributed to multiple sites. This configuration supports distributed services to multiple locations without needing additional satellite bandwidth. As shown, three Infralynx systems are working as a modified "mesh" configuration. This configuration supports the point-to-multi-point configuration that allows multiple nodes to work without a network management "hub". **Figure 11** is a spectrum plot of two Infralynx systems deployed in the "hub" configuration shown in **Figure 7**. The two larger carriers between the lines are from the hub site, which for experimental purposes was the NRL uplink at Bldg 1. Use of a hub configuration will allow for higher bandwidths to be moved to and from each individual Infralynx node compared to the mesh configuration. The hub is required to have one modem for each Infralynx node that is communicating with, and the individual nodes can communicate with each other via the network. The two smaller carriers are the uplinks, or transmit carriers from each of the two Infralynx systems. This configuration requires additional space segment bandwidth, but provides two independent links from the hub to each site. The effective bandwidth does not appear to the users to be "shared" as it does in the mesh configuration. **Figure 12** shows tests that have been performed to measure the full capacity of a representative system **10**. The spectrum represents the space segment utilization that's supports simultaneous connections of 96 voice/data calls, 10Mbps NIPR and 4Mbps SIPR.

Other modules can be incorporated into system **10** as desired for a particular configuration or application. For example, system **10** may optionally include a standard

FAA air traffic control pattern module and VDT in order to track the status of all commercial air traffic over the US at any time. This has obvious relevance and utility in a 9/11/2001-type scenario.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that the scope of the invention should be determined by referring to the following appended claims.